HOW TO USE YOUR HP 12 C CALCULATOR

This document is designed to provide you with (1) the basics of how your HP 12C financial calculator operates, and (2) the typical keystrokes that will be required on the CFA® examination. In this tutorial, the following keystroke and data entry conventions will be used.

< • > and [•] Denote keystrokes
{•} Denotes data input

A. Setting Up Your HP 12C

Important note: The keys of the HP 12C calculator have been assigned multiple functions. Keys are assigned white, orange and blue color codes. To enable the white coded function, just press the desired key. For the orange coded function, press the <f> key at the bottom of the calculator followed by the desired key. For the blue coded function, press the <g> key at the bottom of the calculator followed by the desired key. In this user guide, *all keys are referred to by their white coded function, as they are easier to read and easier to identify*.

The following is a list of the basic preliminary set up features of your HP 12C. You should understand these keystrokes before you begin work on statistical or Time Value of Money (TVM) functions.

Please note that your calculator's sign convention requires that one of the TVM inputs ([PV], [FV], or [PMT]) be a negative number. Intuitively, this negative value represents the cash outflow that will occur in a TVM problem.

1. **To set the number of decimal places that show in your calculator display screen:**

   < f > → {Desired # of decimal places}

   For the exam, I would make sure that the number of decimal places is set to 5.

2. **To switch between annuity-due [BEGIN] and ordinary annuity modes:**

   To switch to the begin mode, enter

   <g> → [7] (The word BEGIN will be displayed at the bottom of the display screen.)

   To switch back to the ordinary annuity mode, enter

   <g> → [8] (The word BEGIN will disappear from the display screen.)

3. Clearing the calculator screen:

To clear the calculator screen, press

[CL*X*]

4. To clear the time value of money memory registers:

< f > → [x⇔y] (This is the key to the left of the white [CL*X*] key in the second row from below.)

This function clears all entries in the time value of money functions (n, i, PV, PMT and FV). This function is important because each TVM function button represents a memory register. If you do not clear your memory you may have erroneous data left over when you perform new TVM computations. Pressing the [CL*X*] key clears the screen only. It does not clear the memory registers for the TVM functions, so please be careful.

5. Clearing your work from the statistical data entry registers:

To clear the single value and (X, Y) coordinate pairs from the statistical memory registers, press:

< f > → [SST]

6. Additional memory registers:

HP 12C provides 20 additional memory registers for data storage. These are numbered 0 to 9 for the first ten, and 0.0 to 0.9 for the last ten registers (yes that is a period before 0 and 9!). To enter data into a memory register press

{Desired value} → [STO] → [Any memory register number, 0 to 0.9]

Example: Store the number 125 in the memory register 0.8

125 → [STO] → [.8] will do the job.

To recall a stored value, press

[RCL] → [Desired memory register number]

In the above example, to recall the stored value 125, press

[RCL] [.8] (This will display 125 on the screen.)

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To clear all memory registers press

< f > → [CL*X*] (This will clear all memory registers as well as the TVM registers.)

B. How to Handle Multiple Payment Periods Per Year:

When a present value or future value problem calls for a number of payments per year that is different from 1, use the following rules.

1. For semi-annual computations:

PMT = (annual PMT) / 2
i = (annual i) / 2
n = (number of years)×2

2. For quarterly computations:

PMT = (annual PMT) / 4
i = (annual i) / 4
n = (number of years)×4

3. For monthly computations:

PMT = (annual PMT) / 12
i = (annual i) / 12
n = (number of years)×12

C. Time Value of Money (TVM) Computations

1. Basic Present Value Computations

If a single cash flow is to occur at some future time period, we must consider the opportunity cost of funds to find the present value of that cash flow. Hence, our goal here is to discount future cash flows to the present using the appropriate discount rate.

Example: suppose you will receive $100 one year from today and that the appropriate discount rate is 8%. The value of that cash flow today is:

{1} → [n]
{100} → [FV]
{0} → [PMT]
{8} → [i]
[PV] gives the result, -$92.59

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Example: Suppose you will receive $1,000 ten years from today and that the appropriate annualized discount rate is 10%. Compute the present value of this cash flow assuming semi-annual compounding

[Note: HP 12C uses Reverse Polish Notation (RPN) methodology of data entry when it comes to performing mathematical calculations such as +, -, /, and *x*.]

{10} → [ENTER] → {2} → [X] → [n]
{10} → [ENTER] → {2} → [÷] → [i]
{0} → [PMT]
{1,000} → [FV]
[PV] gives the result, -$376.89

The result is a negative number due to your calculator's sign convention. Intuitively, to receive $1000 ten years from now at 10% semi-annually, this would cost you $376.89.

2. Basic Future Value

Here, we want to compute how much a given amount today will be worth a certain number of periods from today, given an expected interest rate or compounding rate.

Example: Suppose that you have $1,000 today and can invest this amount at 14% over the next 5 years with quarterly compounding. Compute the value of the investment after 5 years.

{1000} → [CHS] → [PV] (Note: The [CHS] key changes the sign of the numeric value.)
{5} → [ENTER] → {4} → [X] → [n]
{14} → [ENTER] → {4} → [÷] → [i]
{0} → [PMT]
[FV] gives the result, $1,989.79

3. Ordinary Annuities

In an ordinary annuity, a constant cash flow is either paid or received at the end of a particular payment period over the life of an investment or liability. Here, we begin use of the [PMT] key.

Example: You would like to buy a 9%, semi-annual, 8-year corporate bond with a par value of $1,000 (par value represents the terminal value of the bond). Compute the value of this bond today if the appropriate discount rate is 8%. Here, the 9% is the coupon rate of the bond and represents the annual cash flow associated with the bond. Hence, the annual PMT = (0.09) × ($1,000) = $90. ({0.09} → [ENTER] → {1000} → [X] gives the result, $90.)

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The value of the bond today is:

{8} → [ENTER] → {2} → [X] → [n]
{90} → [ENTER] → {2} → [÷] → [PMT]
{8} → [ENTER] → {2} → [÷] → [i]
{1,000} → [FV]
[PV] gives the result, -$1,058.26

Example: You will receive $100 per month for the next three years and you have nothing today. The appropriate annual interest rate is 12%. Compute your accumulated funds at the end of three years.

{3} → [ENTER] → {12} → [X] → [n]
{0} → [PV]
{100} → [PMT]
{12} → [ENTER] → {12} → [÷] → [i]
[FV] gives the result, -$4,307.69

4. Annuity Due

In an annuity due, you receive each constant annuity cash flow at the beginning of each period. You must set your calculator to BEGIN mode by pressing <g> [7]. BEGIN will appear in the calculator's LCD screen.

Example: You will receive $100 per month for the next three years and you have nothing today. The appropriate annual interest rate is 12%. Compute your accumulated funds at the end of three years:

{3} → [ENTER] → {12} → [X] → [n]
{0} → [PV]
{100} → [PMT]
{12} → [ENTER] → {12} → [÷] → [i]
[FV] gives the result, -$4,350.76

Notice that the future value is larger in this case because you receive each cash flow at the beginning of the period, so each cash flow is exposed to one additional compounding period.

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5. Continuous Compounding and Discounting

If the number of compounding periods is said to be continuous, what this means is that the time between compounding periods is infinitesimally small. To discount and compound, you need the magic number $e = 2.718281$.

The formula for continuous compounding of a single cash flow is: $FV = PV \times (e^{rt})$
The formula for continuous discounting is: $PV = FV \times (e^{-rt})$

where:
r = the annualized interest rate
t = the number of years

Example: You have $100 today and have been offered a 6-month continuously compounded investment return of 10%. How much will the investment be worth in six months?

Step 1: Compute r × t =

{0.1} → [ENTER] → {0.5} → [X] gives the result, 0.05

Note that you always use the decimal representative of both the interest rate and time when performing these computations.

Step 2: Compute $e^{r \times t}$

{0.05} → <g> → [1/x]

This gives the result, 1.05127.

Step 3: Find the future value

→ [ENTER] → {100} [X] gives the result, $105.13

Example: You will receive $1,000 eighteen months from today and would like to compute the present value of this amount at 8% with continuous compounding.

Step 1: Compute –r × t

{0.08} → [CHS] → [ENTER] → {1.5} → [X] gives the result, –0.12

Step 2: Compute e^{-rt}

→ <g> → [1/x]

This will give the result: 0.88692

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Step 3: Find the present value

→ [ENTER] → {1000} [X]; will give the result, $886.92

6. Internal Rate of Return (IRR) and Net Present Value (NPV)

Just in case there is a question on the examination that asks for an IRR calculation, the keystrokes are as indicated in the following example:

Example: Project X has the following expected after-tax net cash flows. The firm's cost of capital is 10%. (Note: Clear all previous work.)

Expected Net After-Tax Cash Flows – Project X

Year	*Cash Flow*
0 (initial outlay)	–$2,000
1	1,000
2	800
3	600
4	200

The **IRR** for Project X is:

{2,000} → [CHS] <g> [PM]
{1,000} → <g> [PMT]
{800} → <g> [PMT]
{600} → <g> [PMT]
{200} → <g> [PMT]
<f> [IRR] gives the result, 14.48884.

Remember: The "PV" is the "WHITE" name of the key. We use this convention because the white keys are easier to read and identify.

A note on Net Present Value (NPV): For NPV calculations on the examination, we recommend computing the present value of each individual cash flow and adding them together. No need to memorize more calculator functions - you've got enough to memorize for the exam! However, for the curious, the keystrokes to calculate NPV are provided below:

The **NPV** of Project X is:

{2,000} → [CHS] <g> [PV]
{1,000} → <g> [PMT]
{800} → <g> [PMT]
{600} → <g> [PMT]
{200} → <g> [PMT]
{10} → [i]
<f> [PV] gives the result, $157.63951.

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6. Exponents

Many of the calculations in the CFA program require taking a number to the N^{th} power. On the HP12C, we will use the "white" y^x key to perform this function.

Example: An investment has a stated return of 8 percent. What is the semi-annual effective rate?

Answer: Semi-annual effective rate = $(1 + 0.08 / 2)^2 - 1 = (1.04)^2 - 1$.
{1.04} → [ENTER] → {2} → [y^x] gives the result 1.0816. Then, subtract 1 for the semi-annual rate of 8.16 percent.

Example: Calculate the geometric average for the following stock returns: 22 percent, -5% percent, and 5 percent.

Answer: The geometric average = $[(1.22 \times 0.95 \times 1.05)]^{1/3} - 1 = 1.21695^{1/3} - 1$.
{1.21695} → [ENTER] → {1} → [ENTER] → {3} → [/] → [y^x] = 1.0676, then subtracting 1 gives 6.76 percent.

7. The natural log function (Primarily for CFA® Levels 2 and 3)

The natural log function is intimately related to e^x. In Level 1, you will use this function to calculate a continuously compounded return given a specific holding period return. The natural log function (LN) is also used when working Black-Scholes and Merton Model problems.

Example: The value of the stock is $45 (S) today and the exercise price of a call option that trades on that stock is $50 (X). Calculate the natural log of (S/X).

Step 1: Compute S/X

{45} → [ENTER] → {50} → [÷] gives the result, 0.90

Step 2: Compute LN(S/X)

→ <g> → [%T] gives the result, -0.10536

> Remember, %T is the WHITE key. We use this convention because the white keys are easier to read and identify.

As a check of the relationship between [LN] and [e^x],

→ [ENTER] → <g> → [1/x] gives the result, 0.90.

More precisely, $e^{\ln(x)} = x$, and, $\ln(e^x) = x$.

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D. Your HP 12C Statistical Functions (use at your own risk).

Understanding the previous sections of this document is critical to your success on the exam. What follows are some cool short cuts you can take to calculate the mean and variance of a small data set. Please beware, that in many cases, doing these computations by brute force is sometimes quicker. If you feel you'll have a hard time memorizing these keystrokes for the exam, don't sweat it – focus on the actual formulas and basic calculations. In other words, don't get fancy – it could backfire!

To enter single values as well as data pairs [X,Y], you will use the [∑+] key on the bottom right and to the left of the [+] key. Note that while entering paired values the Y-value is entered first, followed by the X value, and the calculator automatically increases its internal memory register by 1 to identify the location and sequence of the data values entered.

To clear a value that has just been entered (most recent), press

<g> → [ENTER] → <g> [∑+].

To clear the incorrect data point or data pair, key in the incorrect data point or data pair and press

<g> → [∑+]. You should then re-enter the correct data again. Remember, you cannot directly replace incorrect data. You can only clear it and then re-enter it again.

Example: You have been given the following observations that measure the speed of randomly selected vehicles as they pass a particular checkpoint: 30, 42, 32, 35, 28. Compute the mean ($\overline{X}$), population variance, and sample variance for this data set.

Step 1: Enter the data:

{30} → [∑+]; the number 1 will appear in the display
{42} → [∑+]; the number 2 will appear in the display
{32} → [∑+]; the number 3 will appear in the display
{35} → [∑+]; the number 4 will appear in the display
{28} → [∑+]; the number 5 will appear in the display

Step 2: Calculate the statistics. Press

<g> → [0] for the mean $\overline{X}$ = 33.4

<g> → [.] for the sample standard deviation (S_x) = 5.459

Computation of population standard deviation with HP 12C is quite involved and we do not recommend that you use it for this purpose.

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Remember that the population variance differs from the sample variance in that the sum of the squared deviations from the mean is divided by n and n – 1 respectively. In addition, the standard deviation is the square root of the variance.

Example: You have calculated the following returns for an individual stock and the stock market over the past four months. (For this example, we will use the data-pair method of entering the data into the HP12C.)

Month	Ri (Y)	Rm (X)
1	**12%**	**15%**
2	8%	4%
3	9%	12%
4	10%	14%

Calculate the stock's mean return, the market's mean return, and the correlation between the stock's returns and market returns.

Note: Clear all previous work

< f > → [CL*X*]

Step 1: Enter the data. (Remember to enter the y-value first!)

{12} → [ENTER] →{15} → [Σ+]; screen displays 1
{8} → [ENTER] → {4} → [Σ+]; screen displays 2
{9} → [ENTER] → {12} → [Σ+]; screen displays 3
{10} → [ENTER] → {14} → [Σ+]; screen displays 4

Step 2: Calculate the statistics.

Mean of X ($\overline{X}$):	<g> → [0] gives the result, 11.25
Mean of Y ($\overline{Y}$):	<g> → [0] → [x⇔y] gives the result, 9.75
Sample standard deviation $_X$ [S_X]:	<g> → [.] gives the result, 4.992
Population standard deviation:	not recommended on this calculator
Sample standard deviation $_Y$ [S_Y]:	<g> → [.] → [x⇔y] gives the result, 1.708
Population standard deviation:	not recommended on this calculator

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Intercept term(a), Slope Coefficient (b), and Correlation X,Y (r)
To obtain these statistics, you **must** enter the keystrokes in the following order. For example, you cannot calculate the slope coefficient without first calculating the intercept term.

- Intercept term (a): [0] → <g> → [2] gives the result 6.55
- Slope coefficient (b): [1] → <g> → [2] → [x⇔y] → [R↓] → [x⇔y] → [-] gives the result,0.284. (Whew! Now you know why we do not recommend the HP 12C.)
- Correlation X, Y (r): [x⇔y] gives the result0.831

Given this data, we can say that our estimate of the beta of the stock is 0.28, the correlation of stock i's returns relative to the market is 83.1%, and the R^2 of the regression is $(0.831)^2 = 0.691$ or 69.1% (i.e., 69.1 percent of the variation in stock i's returns is explained by the variability in market returns).

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